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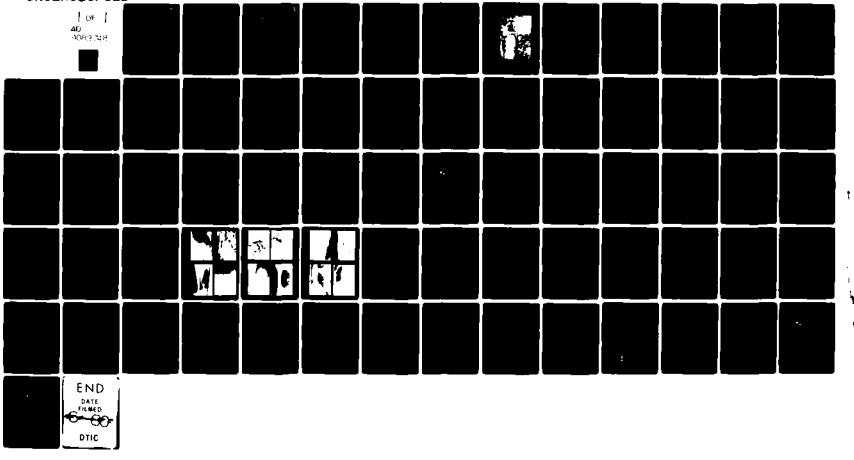

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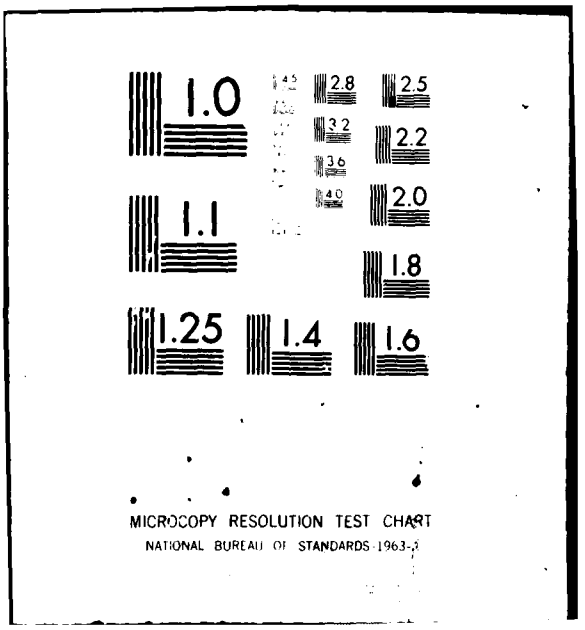
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SUSQUEHANNA RIVER BASIN
KEHLY RUN, SCHUYLKILL COUNTY

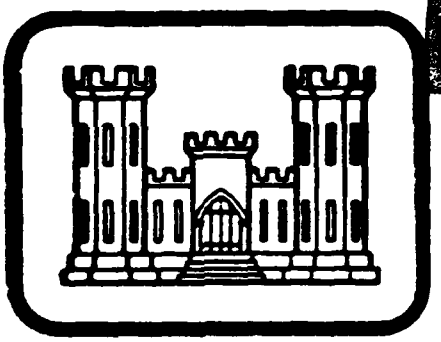
PENNSYLVANIA

KEHLY RUN DAM NO. 5

NDS ID NO. PA-658
DER ID NO. 54-7

SHENANDOAH MUNICIPAL AUTHORITY

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM



Prepared By
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG, PENNSYLVANIA
15931

FOR
DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT CORPS OF ENGINEERS
BALTIMORE, MARYLAND
21203

MARCH, 1980

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SUSQUEHANNA RIVER BASIN

KEHLY RUN, SCHUYLKILL COUNTY

PENNSYLVANIA

National Dam Inspection Program.

KEHLY RUN DAM NO. 5

(NDS ID NO. PA-658

DER ID NO. 54-7)

Susquehanna River Basin, Kehly Run, Schuylkill County, Pennsylvania.

SHENANDOAH MUNICIPAL AUTHORITY

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411-1

JOB

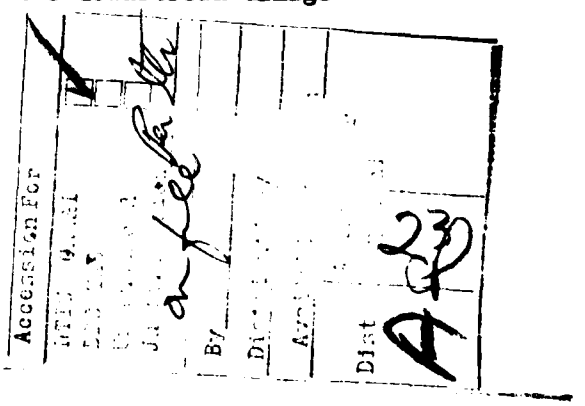
PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in detemining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.



PHASE I REPORT
NATIONAL DAM INSPECTION REPORT

NAME OF DAM	Kehly Run Dam No. 5
STATE LOCATED	Pennsylvania
COUNTY LOCATED	Schuylkill
STREAM	Kehly Run
DATE OF INSPECTION	November 7 and 16, 1979

ASSESSMENT

The assessment of Kehly Run Dam No. 5 is based upon visual observations made at the time of inspection, review of available records and data, hydraulic and hydrologic computations and past operational performance.

Kehly Run Dam No. 5 is a high hazard-small size dam. The spillway design flood was selected as the PMF. The spillway and reservoir are capable of controlling approximately 75% of the PMF without overtopping the earth embankment. Based on criteria established by the Corps of Engineers, this spillway is termed inadequate. The long term affect of the seepage and wet areas on the abutments, and erosion of the slopes should be evaluated. Heavy growth of vegetation on the slopes should be selectively removed.

The following recommendation and remedial measures should be instituted immediately.

1. A detailed hydrologic and hydraulic study should be conducted by a professional engineer knowledgeable in dam design to increase spillway capacity. All dams in the Kehly Run system which have inadequate spillways should have their spillway capacities increased.

2. A stability analysis of the embankment should be conducted by a registered professional engineer knowledgeable in dam design and construction because of the steep downstream slope, erosion of both slopes and crest, seepage and past history of slope failure.

3. The brush and trees on the upstream and downstream slopes should be removed under the direction of a professional engineer knowledgeable in dam design and construction.

4. All wet and seepage areas should be monitored at regular intervals. Readings should be periodically evaluated by a professional engineer knowledgeable in dam design.

5. Positive drainage should be provided at the toe of dam to eliminate ponded areas on each abutment.

6. Some means of positive closure of the drainline should be developed in case of emergencies.

7. All valves should be exercised and lubricated at regular intervals.

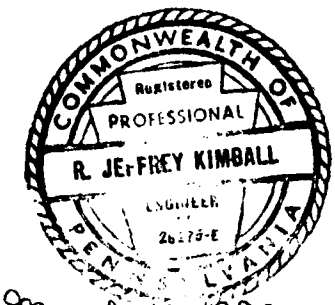
8. A subsidence investigation should be conducted by the owner or his engineer to determine the effects of past and present mining beneath the reservoir.

9. A warning system should be instituted to warn downstream residents of high water levels or imminent failure of the dam.

10. Regular safety inspections should be conducted in accordance with the provisions stipulated by the Commonwealth of Pennsylvania regarding inspection of dams.

SUBMITTED BY:

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS



March 18, 1980
Date

R. Jeffrey Kimball
R. Jeffrey Kimball, P.E.

APPROVED BY:

25 March 1980
Date

James W. Peck
JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Overview of Kehly Run Dam No. 5. Kehly Run Dam No. 6 upstream (upper left corner) and Kehly Run Dam No. 4 downstream (lower right corner).

TABLE OF CONTENTS

APPENDICES

PHASE I
NATIONAL DAM INSPECTION PROGRAM
KEHLY RUN DAM NO. 5
NDI. I.D. NO. PA 658
DER I.D. NO. 54-19

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Kehly Run Dam No. 5 is an earthfill dam which is semi-circular in plan and convex in the downstream direction. The embankment is 1,050 feet long and 25 feet high. The upstream slope is 1H:1V and the downstream slope is 1.5H:1V. The crest width varies from 15 feet to 25 feet wide. The lower part of the downstream slope of the embankment consists of hand placed stone. The upper portion of the downstream slope consists of an earthfill.

The reservoir drain conduit consists of one 6" cast iron pipe. Flow through the outlet conduit is controlled by a valve chamber located at the toe of the dam below the tailwater.

The spillway is located on the left abutment and consists of a stonelined chute. This stonelined chute has five concrete cutoff walls located beneath the stone masonry. The spillway weir consists of a concrete wall 2 feet thick and 5 1/2 feet high. The spillway is 39 feet long with 4H:1V sideslopes. The spillway discharge channel extends 625 feet downstream of the weir and bypasses Kehly Run Dam No. 4.

Immediately upstream of Kehly Dam No. 5 is Kehly Run Dam No. 6. This dam is an earthfill dam approximately 1200 feet long and 25 feet high.

b. Location. The dam is located on Kehly Run, 1 mile north of Shenandoah, Schuylkill County, Pennsylvania. Kehly Run Dam No. 5 can be located on the Shenandoah, U.S.G.S. 7.5 minute quadrangle.

c. Size Classification. Kehly Run Dam No. 5 is a small size structure (25 feet high, 82 acre-feet).

d. Hazard Classification. Kehly Run Dam No. 5 is a high hazard dam. Downstream conditions indicate that loss of more than a few lives is probable should the structure fail. Immediately downstream of Kehly Run Dam No. 5 are two more reservoirs in a steep, narrow, confined valley. Before the valley discharges into the town of Shenandoah.

e. Ownership. Kehly Run Dam No. 5 is owned by The Shenandoah Municipal Authority. Correspondence should be addressed to:

Shenandoah Municipal Authority
26 West Lloyd Street
Shenandoah, PA 17976
Attention: Charles Dallazia, Manager
717-462-1904

f. Purpose of Dam. Kehly Run Dam No. 5 is used for water supply.

g. Design and Construction History. The dam was reportedly constructed in 1882. No information is available on the design or construction history. In 1946 the spillway located on the left abutment was reconstructed and enlarged. At this time the dual spillways located on each abutment were abandoned.

h. Normal Operating Procedure. Fetter Pond is located upstream of Kehly Run Dam No. 5. Fetter Pond is a strip mine pond with a natural outlet. During dry periods water is pumped into Fetter Pond for storage. Downstream of Fetter Pond is Kehly Run Dam No. 6. Kehly Run Dam No. 6 has two spillways (one located on each abutment). Kehly Run Dam No. 6 is used as a holding pond for the downstream reservoirs. Water discharges through the spillways into Kehly Run Dam No. 5. Downstream of Kehly Run Dam No.5 are Kehly Run Dams No. 4 and No. 3. Water is drawn off Kehly Run Dam No. 3 into the water system.

1.3 Pertinent Data.

a. Drainage Area. 0.4 square miles

b. Discharge at Dam Site (cfs).

Maximum known flood at dam site	Unknown
Emergency spillway capacity at top of dam	766

c. Elevation (U.S.G.S. Datum) (feet). - Field survey based on spillway crest given as 1660 on construction drawings.

Top of dam - low point	1663.1
Top of dam - design height	Unknown
Maximum pool - PMF	1663.2
Normal pool	1660
Spillway crest	1660
Tailwater on day of inspection	1643.3
Toe of dam	Submerged

d. Reservoir (feet).

Length of maximum pool (PMF)	1200'
Length of normal pool	1000'

e. Storage (acre-feet).

Normal pool	54
Top of dam	82

f. Reservoir Surface (acres).

Top of dam	10.5
Normal pool	9
Spillway crest	9

g. Dam.

Type	Earthfill
Length	1050'
Height	25'
Top width	Varies (15 to 25')
Side slopes - upstream	1H:1V
- downstream	1.5H:1V

SECTION 2
ENGINEERING DATA

2.1 Design. Review of information in the files of the Commonwealth of Pennsylvania, Department of Environmental Resources and the owner's files revealed one construction drawing of the spillway modification, inspection reports, permit, photographs and correspondence were available for review. No detailed information on the design and original construction of the dam were available for review. All information available was reviewed for this study.

2.2 Construction. No information is available on the original dam construction.

2.3 Operation. No operating records are maintained.

2.4 Evaluation.

a. Availability. Engineering data were provided by PennDER, Bureau of Dams and Waterways Management and by the owner. The manager of the Municipal Authority was interviewed on operation and maintenance of the dam. The owner did not provide any information on past deep mining activities in the areas of the dam and reservoir.

b. Adequacy. A detailed study cannot be performed on this structure because of the lack of design and construction data. The Phase I Report is based upon visual inspection, review of available data, and the hydrologic and hydraulic analyses.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The onsite inspection of Kehly Run Dam No. 5 was conducted by personnel of L. Robert Kimball and Associates on November 7 and 16, 1979. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and sections of toe not submerged.
2. Examination of the spillway facilities, exposed portion of any outlet works and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.
4. Evaluation of the downstream area hazard potential.

b. Dam. The dam appears to be in fair condition. The dam embankment is shaped in a semi-circle. From a brief survey conducted during inspection, it was noted that the dam crest elevation is fairly consistent. The upstream slope is 1H:1V with riprap missing throughout most of the embankment length. The crest width varies from 15 feet to 25 feet wide. The lower portion of the downstream slope consists of hand placed stone and is near vertical. The upper portion of the downstream slope consists of an earth embankment. The average slope on the downstream is 1.5H:1V. Both the upstream and downstream slopes and the crest are covered with trees and small brush. Many wet areas are located along the downstream toe of the dam (See page A-12). Along the left abutment beyond the toe of dam several seepage areas were noted. Seepage in this area was estimated at 2 gallons per minute. In addition, a wet area was noted at the toe of dam to the right of the tailwater. On the right abutment beyond the toe of dam is an extensive swampy area. An auxiliary spillway was located in this area prior to reconstruction of the new spillway. A diversion ditch is located along the right abutment. This diversion ditch formally acted as a spillway exit channel.

c. Appurtenant Structures. The 39 foot wide bottom width trapezoidal shaped spillway is located on the left abutment. The spillway and spillway exit channel are 625 feet long and bypass Kehly Run Dam No. 4. The spillway and spillway exit channel are lined with hand placed stone masonry in very good condition. The weir consists of a concrete wall approximately 5 1/2 feet high. The concrete is in good condition.

The outlet works consist of one 6" cast iron pipe through the embankment. Flow is controlled by a valve chamber located at the toe of dam. No upstream shut off is provided on this pipe. The pipe was unobserved during the inspection.

d. Reservoir Area. The watershed consists mostly of woodland and Kehly Run Dam No. 6. The reservoir slopes are gentle and are not susceptible to massive landslides which would affect the storage volume of the reservoir or overtopping of the dam by displacing water. However, failure of Kehly Run Dam No. 6 probably would cause overtopping of Kehly Run Dam No. 5.

e. Downstream Channel. The downstream channel of Kehly Run is rather narrow and steep. Kehly Run Dams No. 4 and No. 3 are located downstream of the dam. Kehly Run discharges into the borough of Shenandoah.

3.2 Evaluation. In general, the embankment and appurtenant structures appear to be in fair condition. The seepage areas at the toe of dam should be monitored at regular intervals.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures. The reservoir is maintained at the spillway crest elevation 1660.0. Excess inflow discharges over the spillway crest. The drainline is reportedly opened at regular intervals.

4.2 Maintenance of the Dam. No planned maintenance schedule exists. Maintenance of the dam has been lacking. Maintenance of the dam is considered poor.

4.3 Maintenance of Operating Facilities. The owner reported that the reservoir drain is opened at regular intervals. Maintenance of the operating facilities is considered fair.

4.4 Warning System in Effect. At the time of inspection no system was in effect to warn downstream residents of large spillway discharges or imminent failure of the dam.

4.5 Evaluation. Maintenance of the dam is considered poor. Maintenance of the operating facilities is considered fair. There is no warning system in effect to warn downtream residents.

SECTION 5
HYDRAULICS AND HYDROLOGY

5.1 Evaluation of Features.

a. Design Data. No calculations or design data pertaining to hydrology were available.

b. Experience Data. No rainfall, runoff or reservoir data were available. The spillway has reportedly functioned in the past.

c. Visual Observations. The spillway appeared to be in good condition. The concrete control section is trapezoidal shaped with sideslopes equal to 4H:1V and the entrance is unrestricted.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, Baltimore District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers, Davis, California, July, 1978. The major methodologies or key input data for this program are discussed briefly in Appendix D.

5.2 Evaluation Assumptions. To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions.

1. The initial water level before the flood is elevation 1660 feet.

2. For the overtopping analysis the top of dam elevation of 1663.1 feet was assumed for the entire length of the crest of 1150 feet.

3. The flood was routed through Kehly Run Dam No. 6.

5.3 Summary of Overtopping Analysis. Complete summary sheets for the computer output are presented in Appendix D.

Peak inflow (PMF)	1012 cfs
Spillway capacity	766 cfs

a. Spillway Adequacy Rating. The Spillway Design Flood (SDF) for this dam is the PMF. The SDF is based on the hazard and size classification of the dam. Based on the following definition provided by the Corps of Engineers, the spillway is rated as inadequate as a result of our hydrologic analysis.

> Inadequate - For all high hazard dams which do not safely pass the SDF (PMF).

The spillway and reservior are capable of controlling 75% of PMF without overtopping the embankment. The computer printout of the hydrology is included in Appendix D.

5.4 Summary of Dam Breach Analysis. As the subject dam can satisfactorily pass 50% of the PMF without failure (based on our analysis) it was not necessary to perform a breach analysis and downstream routing of flood wave.

Special Note: Because failure of any dam in the Kehly Run system could result in failure of any downstream dam, the spillway capacity of all dams with inadequate spillways, should be increased.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The top part of the earth embankment consists of a sandy material which has eroded on the crest, upstream and downstream slopes. The upper portion of these slopes have eroded so that they are flatter than the downstream portions of the slopes. Trees and brush are growing on both the upstream and downstream slopes and the crest. Seepage is exiting from the left abutment and several locations on the right abutment (See page A-12). The downstream slope is very steep and appears to be bulging. Tailwater obscured close examination of the toe.

b. Design and Construction Data. No stability analyses are on record for this dam. No data are available on the design or construction of the dam. An inspection report prepared in 1920 indicated that a large slump on the upstream slope of the dam was present. This slump went unrepaired for several years. The correspondence and inspection reports do not indicate when or if this slump was repaired. The slide or slump area was not noted during the inspection.

c. Operating Records. No operating records are maintained.

d. Post Construction Changes. In 1946 the spillway located on the right abutment was abandoned and the spillway on the left abutment was enlarged and repaired. No other information is available on any post construction changes.

e. Seismic Stability. The dam is located in seismic zone 1. No seismic stability analyses has been performed. Normally, it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected loading.

SECTION 7
ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety. The dam appears to be in fair condition. The heavy growth of trees and vegetation, seepage and wet spots and erosion indicate that the dam is in need of repair and maintenance. The visual observations, review of available information, hydrologic and hydraulic calculations and past operational performance indicate that Kehly Run Dam No. 5 spillway is adequate. The spillway is capable of controlling 75% of the PMF without overtopping. According to the Corps of Engineers definitions the spillway is termed inadequate. All dams in the Kehly Run system which have inadequate spillways should have their spillway capacities increased. No adequate stability analyses have been performed for this structure. The long term effect of the seepage is unknown. Because of the very steep downstream slope; erosion on the upstream, downstream and crest; seepage areas, past history of slope failure, bulging of downstream slope, and tailwater condition, it is recommended that a stability analysis be conducted.

b. Adequacy of Information. The information available is not sufficient to complete the detailed report. The Phase I report is based upon visual observations, hydrologic and hydraulic calculations, and available information.

c. Urgency. The recommendations suggested below should be implemented immediately.

d. Necessity for Further Investigation. To complete some of the recommendations/remedial measures outlined below, additional investigations are required.

7.2 Recommendations/Remedial Measures.

1. A detailed hydraulic and hydrologic study should be conducted by a professional engineer knowledgeable in dam design to increase spillway capacity. All dams in the Kehly Run system which have inadequate spillways should have their spillway capacities increased.

2. A stability analysis of the embankment should be conducted by a registered professional engineer knowledgeable in dam design and construction because of the steep downstream slope, erosion of both slopes and crest, seepage and past history of slope failure.

3. The brush and trees on the upstream and downstream slopes should be removed under the direction of a professional engineer knowledgeable in dam design and construction.

4. All wet and seepage areas should be monitored at regular intervals. Readings should be periodically evaluated by a professional engineer knowledgeable in dam design.

5. Positive drainage should be provided at the toe of dam to eliminate ponded areas.

6. Some means of positive closure of the drainline should be developed in case of emergencies.

7. All valves should be exercised and lubricated at regular intervals.

8. A subsidence investigation should be conducted by the owner or his engineer to determine the effects of past and present mining beneath the reservoir.

9. A warning system should be instituted to warn downtream residents of high water levels or imminent failure of the dam.

10. Regular safety inspections should be conducted in accordance with the provisions stipulated by the Commonwealth of Pennsylvania regarding inspection of dams.

APPENDIX A
CHECKLIST, VISUAL INSPECTION, PHASE I

CHECK LIST
VISUAL INSPECTION
PHASE I

NAME OF DAM Kehly Run Dam No. 5 COUNTY Schuylkill STATE Pennsylvania ID# PA 658

TYPE OF DAM Earth and rock fill HAZARD CATEGORY High

DATE(s) INSPECTION Nov. 7,15, 1979 WEATHER Cloudy, warm TEMPERATURE 50°

POOL ELEVATION AT TIME OF INSPECTION 1660.0 M.S.L. TAILWATER AT TIME OF INSPECTION 1643.3 M.S.L.

INSPECTION PERSONNEL:

R. Jeffrey Kimball, P.E. - L. Robert Kimball and Associates

James T. Hockensmith - L. Robert Kimball and Associates

O.T. McConnell - L. Robert Kimball and Associates

James T. Hockensmith RECORDER

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None noted.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None noted.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	The upper portions of the upstream and downstream slopes have eroded.	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	Vertical alignment is fairly consistent. Any deflections of the horizontal alignment of the dam is difficult to determine because of the shape of the dam.	
RIPRAP FAILURES	Extensive areas of the upstream slope do not have riprap and are eroding.	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
VEGETATION	Trees and brush are located on both the upstream and downstream slopes and the crest.	
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Appear to be good with the exception of seepage as indicated below.	
ANY NOTICEABLE SEEPAGE	Seepage is located on each abutment and near the toe of dam - See page A-12 for location and quantities.	
STAFF GAUGE AND RECORDER	None.	
DRAINS	None.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	Not applicable.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not applicable.	
DRAINS	Not applicable.	
WATER PASSAGES	Not applicable.	
FOUNDATION	Not applicable.	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not applicable.	
STRUCTURAL CRACKING	Not applicable.	
VERTICAL AND HORIZONTAL ALIGNMENT	Not applicable.	
MONOLITH JOINTS	Not applicable.	
CONSTRUCTION JOINTS	Not applicable.	
STAFF GAUGE OR RECORDER	Not applicable.	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Outlet conduit unobserved. Reportedly one 6" cast iron pipe.	
INTAKE STRUCTURE	Unobserved.	
OUTLET STRUCTURE	Discharges below tailwater into Kehly Run Dam No. 4. Top portion of valve chamber visible in tailwater. Condition is partly deteriorated.	
OUTLET CHANNEL	None.	
EMERGENCY GATE	In valve chamber beneath tailwater.	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	In good condition.	
APPROACH CHANNEL	Lake.	
DISCHARGE CHANNEL	Hand placed masonry in good condition.	
BRIDGE AND PIERS	None.	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not applicable.	
APPROACH CHANNEL	Not applicable.	
DISCHARGE CHANNEL	Not applicable.	
BRIDGE AND PIERS	Not applicable.	
GATES AND OPERATION EQUIPMENT	Not applicable.	

DOWNSTREAM CHANNEL

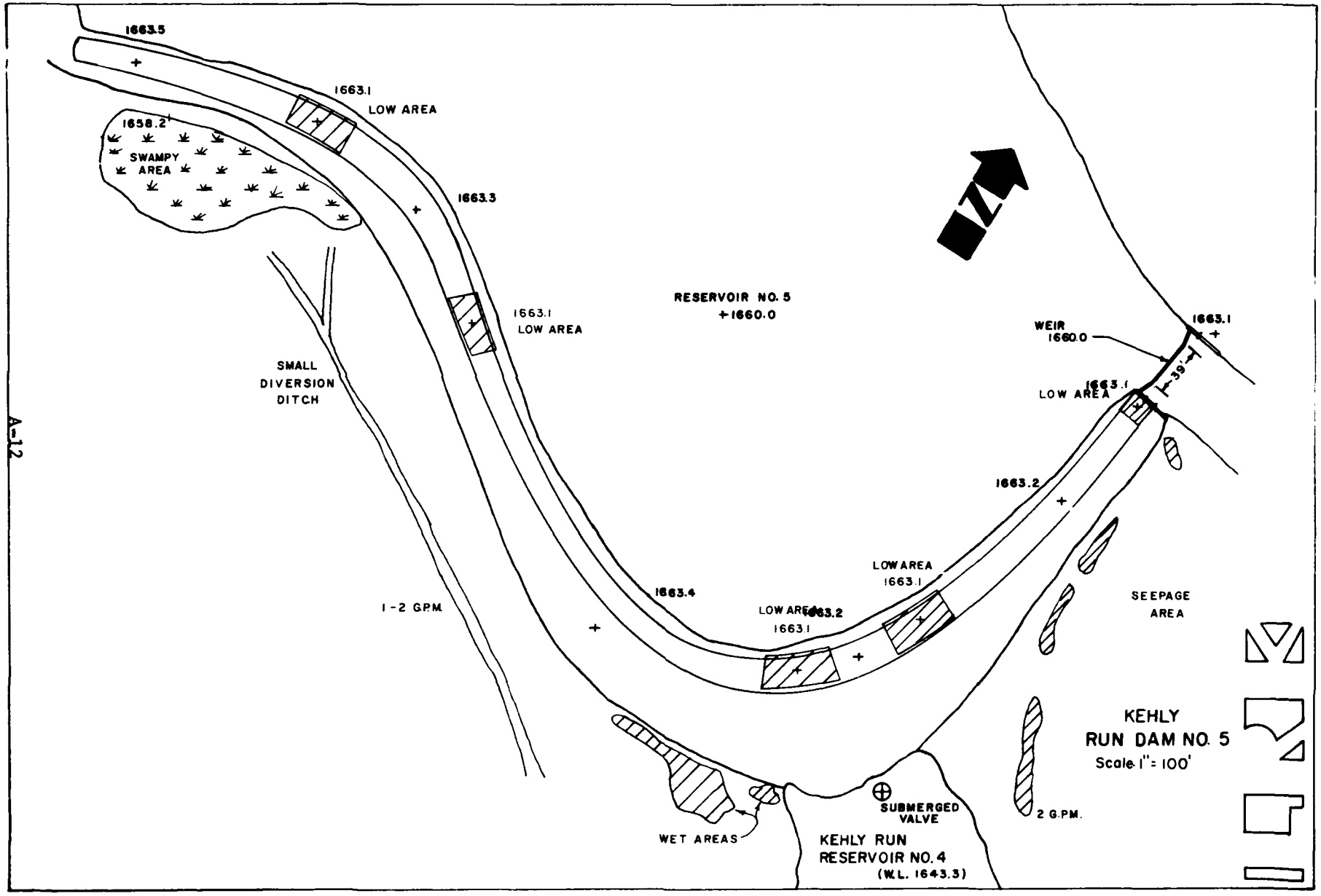
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Kehly Run downstream of Kehly Run Dam No. 5 narrow and confined with several reservoirs before widening out in Shenandoah Borough.	
SLOPES	Appear to be stable.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately 400 homes - 1,600 people.	

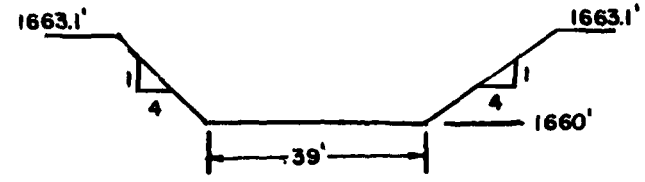
RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Moderate. Appear to be stable.	
SEDIMENTATION	Does not appear to be excessive because of Kehly Run Dam No. 6 upstream.	

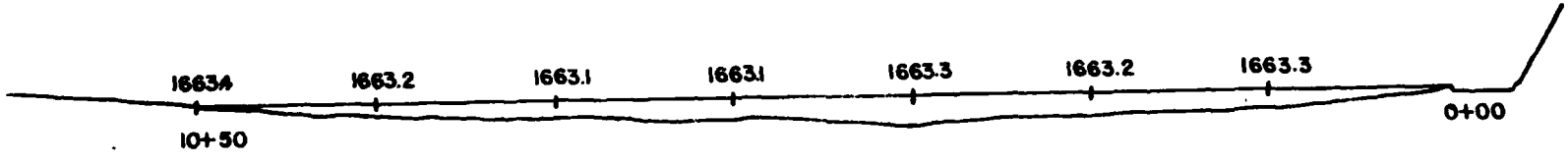
INSTRUMENTATION

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None.	
OBSERVATION WELLS	None.	
WEIRS	None.	
PIEZOMETERS	None.	
OTHER	None.	


1663.5
1663.1
LOW AREA
1658.2
SWAMPY AREA
1663.3
1663.1
LOW AREA
RESERVOIR NO. 5
+1660.0
WEIR
1660.0
1663.1
1663.1
LOW AREA
~39'
SMALL DIVERSION DITCH
1663.2
LOW AREA
1663.1
1663.4
LOW AREA
1663.2
1663.1
SEEPAGE AREA
1-2 G.P.M.
KEHLY
RUN DAM NO. 5
Scale 1" = 100'
SUBMERGED VALVE
2 G.P.M.
WET AREAS
KEHLY RUN
RESERVOIR NO. 4
(W.L. 1643.3)



SPILLWAY PROFILE
(Not to Scale)



PROFILE
LOOKING UPSTREAM

KEHLY RUN NO. 5
Scale 1"=150'

APPENDIX B
CHECKLIST, ENGINEERING DATA, DESIGN, CONSTRUCTION, OPERATION, PHASE I

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM Kehly Run Dam No. 5

ID# PA 658

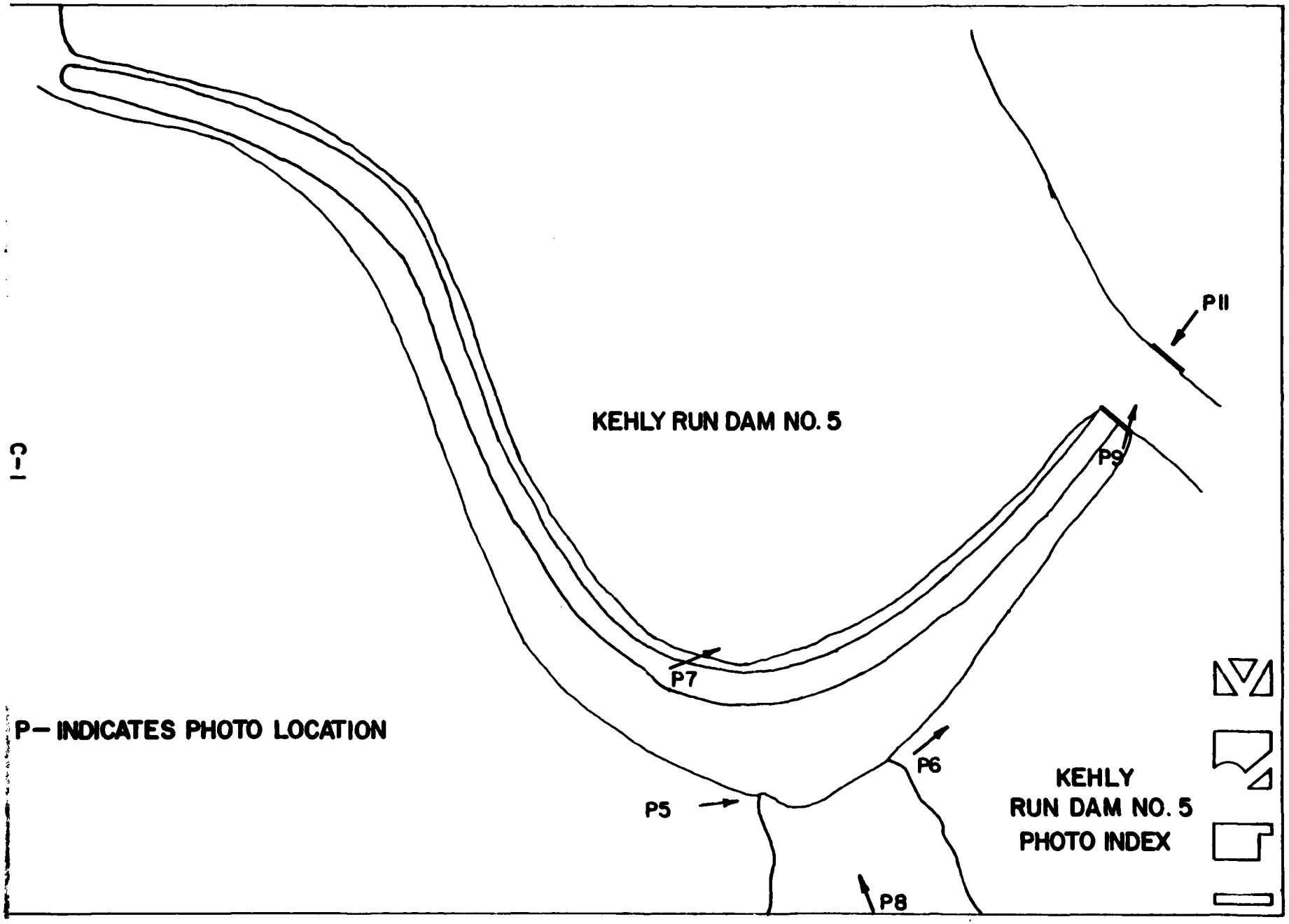
ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. quadrangle.
CONSTRUCTION HISTORY	None.
TYPICAL SECTIONS OF DAM	None.
OUTLETS - PLAN - DETAILS - CONSTRAINTS - DISCHARGE RATINGS RAINFALL/RESERVOIR RECORDS	None. None. None. None. None.

ITEM	REMARKS
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS *HYDROLOGY & HYDRAULICS* DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Unknown.
POST-CONSTRUCTION SURVEYS OF DAM	Unknown.
BORROW SOURCES	Unknown.

ITEM	REMARKS
MONITORING SYSTEMS	None.
MODIFICATIONS	Unknown.
HIGH POOL RECORDS	None.
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Unknown.
MAINTENANCE OPERATION RECORDS	None.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Drawings on spillway modification.
OPERATING EQUIPMENT PLANS & DETAILS	None.

APPENDIX C
PHOTOGRAPHS


KEHLY RUN DAM NO. 5
P11
P9
P7
P6
P5
P8
P- INDICATES PHOTO LOCATION
KEHLY
RUN DAM NO. 5
PHOTO INDEX

KEHLY RUN DAM NO. 5

Photograph Descriptions

Sheet 1. Front

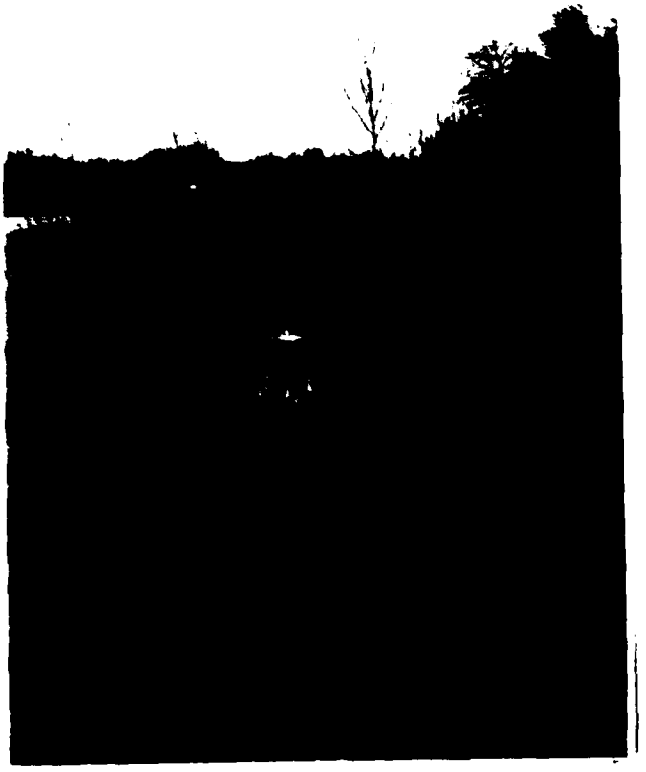
(1) Upper left - Left spillway entrance and upstream slope of Kehly Run Dam No. 6.
(2) Upper right - Kehly Run Dam No. 5. Spillway located on left abutment.
(3) Lower left - Fetters Pond located upstream of Kehly Run Dam No. 5.
(4) Lower right - Right spillway of Kehly Run Dam No. 6.

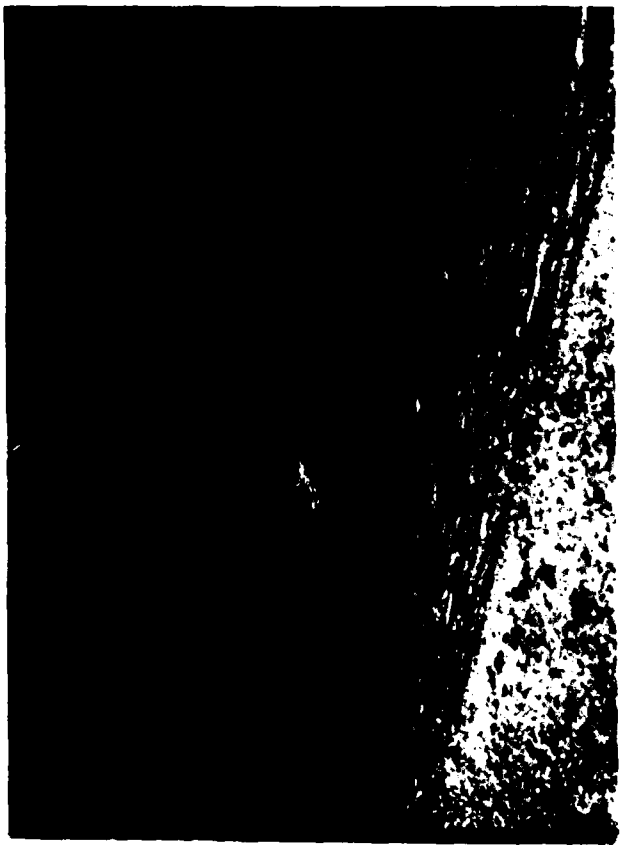
Sheet 1. Back

(5) Upper left - Downstream slope of Kehly Run Dam No. 5 at maximum section. Tailwater of Kehly Run Dam No. 4 on right.
(6) Upper right - Downstream slope of dam with heavy vegetation and wet areas at toe.
(7) Lower left - Upstream slope of Kehly Run Dam No. 5.
(8) Lower right - Downstream slope of Kehly Run Dam No. 5 viewed from Kehly Run Dam No. 4.

Sheet 2. Front

(9) Upper left - Spillway weir.
(10) Upper right - Downstream exposure (Shenandoah Borough) below Kehly Run Dam No. 3. Coal refuse embankment on right.
(11) Lower left - Spillway and crest viewed from left abutment.
(12) Lower right - Overview of Kehly Run Dam Nos. 4,5,6.





APPENDIX D
HYDROLOGY AND HYDRAULICS

APPENDIX D
HYDROLOGY AND HYDRAULICS

Methodology. The dam overtopping and breach analyses were accomplished using the systemized computer program HEC-1 (Dam Safety Investigation), September, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. A brief description of the methodology used in the analysis is presented below.

1. Precipitation. The Probable Maximum Precipitation (PMP) is derived and determined from regional charts prepared from past rainfall records including "Hydrometeorological Report No. 40" prepared by the U.S. Weather Bureau.

The index rainfall is reduced from 10% to 20% depending on watershed size by utilization of what is termed the HOP Brook adjustment factor. Distribution of the total rainfall is made by the computer program using distribution methods developed by the Corps.

2. Inflow Hydrograph. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for reservoir routing.

The unit hydrograph is developed using the Snyder method. This method requires calculation of several key parameters. The following list gives these parameters their definition and how they were obtained for these analysis.

Parameter	Definition	Where Obtained
Ct	Coefficient representing variations of watershed	From Corps of Engineers*
L	Length of main stream channel miles	From U.S.G.S. 7.5 minute topgraphic
Lca	Length on main stream to centroid of watershed	From U.S.G.S. 7.5 minute topographic
Cp	Peaking coefficient	From Corps of Engineers*
A	Watershed size	From U.S.G.S. 7.5 minute topographic

*Developed by the Corps of Engineers on a regional basis for Pennsylvania.

3. Routing. Reservoir routing is accomplished by using Modified Plus routing techniques where the flood hydrograph is routed through reservoir storage. Hydraulic capacities of the outlet works, spillways and the crest of the dam are used as outlet controls in the routing.

The hydraulic capacity of the outlet works can either be calculated and input or sufficient dimensions input and the program will calculate an elevation discharge relationship.

Storage in the pool area is defined by an area - elevation relationship from which the computer calculates storage. Surface areas are either planimetered from available mapping or U.S.G.S. 7.5 minute series topographic maps or taken from reasonably accurate design data.

4. Dam Overtopping. Using given percentages of the PMF the computer program will calculate the percentage of the PMF which can be controlled by the reservoir and spillway without the dam overtopping.

5. Dam Breach and Downstream Routing. The computer program is equipped to determine the increase in downstream flooding due to failure of the dam caused by overtopping. This is accomplished by routing both the pre-failure peak flow and the peak flow through the breach (calculated by the computer with given input assumptions) at a given point in time and determining the water depth in the downstream channel. Channel cross-sections taken from U.S.G.S. 7.5 minute topographic maps were used in the downstream flood wave routing. Pre and post failure water depths are calculated at locations where cross-sections are input.

HYDROLOGY AND HYDRAULICS ANALYSIS
DATA BASE

NAME OF DAM: Kehly Run Dam No. 5

PROBABLE MAXIMUM PRECIPITATION (PMP) = 22.2 (1.005) = 22.3"

STATION	1	2	3
Station Description	Kehly Run No. 6	Kehly Run No. 5	
Drainage Area (square miles)	0.29	0.11	
Cumulative Drainage Area (square miles)	0.29	0.40	
Adjustment of PMF for Drainage Area (%)(1)			
6 hours	117	117	
12 hours	127	127	
24 hours	136	136	
48 hours	143	143	
72 hours	145	145	
Snyder Hydrograph Parameters			
Zone (2)	13	13	
Cp (3)	0.50	0.50	
Ct (3)	1.85	1.85	
L (miles) (4)	0.4	0.4	
Lca (miles) (4)	0.2	0.2	
tp = $Ct(LxLca)^{0.3}$ hrs.	0.87	0.87	
Spillway Data	Lt. Rt.		
Crest Length (ft)	9 26	39	
Freeboard (ft)	3.5	3.1	
Discharge Coefficient	3.1 C'=0.95	C'=0.95	
Exponent	1.5 N/A	N/A	

(1) Hydrometeorological Report 40 (Figure 1), U.S. Army Corps of Engineers, 1965.

(2) Hydrological zone defined by Corps of Engineers, Baltimore District, for determining Snyder's coefficients (C_p and C_t).

(3) Snyder's Coefficients.

(4) L=Length of longest water course from outlet to basin divide. L_{ca}=Length of water course from outlet to point opposite the centroid of drainage area.

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Drainage Area - 0.4 mi Wooded mild slopes

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 42 ac.ft

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 143 ac.ft

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 1663.1 feet

SPILLWAY CREST:

a. Elevation 1660.0 feet
b. Type Trapezoidal
c. Width 39 feet - bottom
d. Length Unknown
e. Location Spillover Left abutment
f. Number and Type of Gates None

OUTLET WORKS:

a. Type 6" CIP
b. Location Maximum Section - embankment
c. Entrance inverts Unknown
d. Exit inverts Unknown
e. Emergency draindown facilities 6" CIP

HYDROMETEOROLOGICAL GAUGES:

a. Type None
b. Location None
c. Records None

MAXIMUM NON-DAMAGING DISCHARGE: Unknown

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EBENSBURG PENNSYLVANIA

DAM NAME KEHLY RUN No. 5
I.D. NUMBER 54-19
SHEET NO. 1 OF 4
BY OTM DATE 1-25-80

LOSS RATE AND BASE FLOW PARAMETERS

As RECOMMENDED BY CORPS OF ENGINEERS, BALTIMORE DISTRICT.

STRTL = 1 INCH
CNSTL = 0.05 IN/HR
STRTQ = 1.5 cfs/mi^2
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.0

ELEVATION - AREA - CAPACITY RELATIONSHIPS

FROM USGS 7.5-MIN. QUAD., DER FILES AND FIELD INSPECTION DATA.

AT SPILLWAY CREST ELEVATION = 1660'
INITIAL STORAGE = 54 AC.FT
POND SURFACE AREA = 8 AC

AT ELEV. 1680, AREA = 23 ACRES

FROM CONIC METHOD FOR RESERVOIR VOLUME. FLOOD HYDROGRAPH PACKAGE (HEC-1), DAM SAFETY VERSION (USERS MANUAL).

$H = 3V/A$
$= 3(54)/8$
$= 162/8$
$= 20.3'$

ELEVATION WHERE AREA EQUALS ZERO;

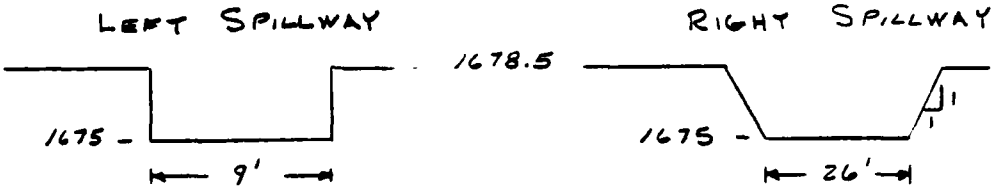
$1660' - 20.3' = 1639.7'$

AREA	#A	0	8	23	
ELEV.	#E	1639.7	1660	1680	

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME KEHLY RUN No. 5
I.D. NUMBER 54-19
SHEET NO. 2 OF 4
BY OYM DATE 2-25-80

DISCHARGE RATING CURVE (KEHLY RUN No. 6)



(NOT TO SCALE)

ELEV. (FT.)	LEFT C = 3.1 ℓ = 9'		RIGHT C' = 0.95, B = 26', Z = 1		DISCHARGE *Q (cfs)
	h (Ft)	Q_1 (cfs)	hp (Ft.)	Q_2 (cfs)	
1675	0	0	0	0	0
1676	1	28	1	78	110
1677	2	79	2	227	310
1678	3	145	3	428	570
1678.5	3.5	183	3.5	545	730
1679	4	223	4	674	900
1680	5	312	5	965	1280
1685	10	882	10	3053	3940
1690	15	1621	15	6213	7830

*VALUES ROUNDED TO NEAREST 10 cfs.

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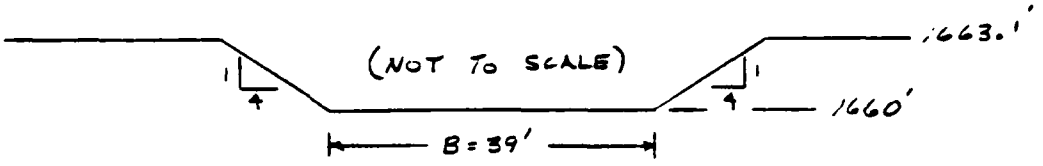
EBENSBURG PENNSYLVANIA

DAM NAME KEHLY RUN No. 5
I.D. NUMBER 54-19
SHEET NO. 3 OF 4
BY OTM DATE 1-25-80

DISCHARGE RATING CURVE (KEHLY RUN No. 5)



ELEV. (FT.)	h_p (FT.)	*Q (cfs)
1660	0	0
1660.5	.5	40
1661	1	120
1661.5	1.5	230
1662	2	370
1662.5	2.5	530
1663	3	720
1664	4	1180
1665	5	1740
1670	10	6240

*VALUES ROUNDED TO NEAREST 10 C.F.S.

$B = 39'$
$z = 4$
$C' = 0.95'$

FROM: $Q = 8.03\, C'\, h_v^{1/2} (h_p - h_v) [B + z(h_p - h_v)]$

WHERE $h_v = \dfrac{3(2z\,h_p + B) - (16z^2 h_p^2 + 16z\,B\,h_p + 9B^2)^{1/2}}{10\,z}$

SOURCE: WATER AND WASTEWATER ENGINEERING
by FAIR, GEYER & OKUM 1966 p. (11-14) & (11-15)

LOW DAMS
BY NATIONAL RESOURCES COMMITTEE WASH. DC.
1938 Eq. (7) & (8)

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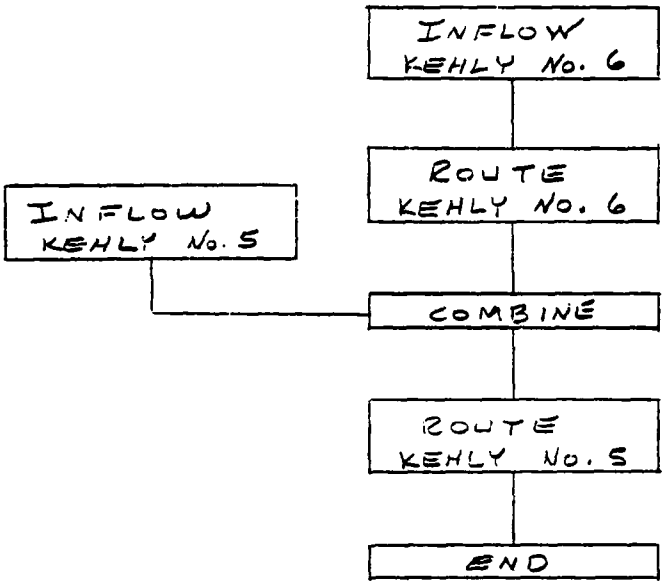
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME KEHLY RUN No. 5
I.D. NUMBER 54-19
SHEET NO. 4 OF 4
BY OTM DATE 1-25-80

OVERTOP PARAMETERS

TOP OF DAM ELEV. (LOW SPOT) = 1663.1'
LENGTH OF DAM (EXCLUDING SPILLWAY) = 1150'
COEFFICIENT OF DISCHARGE (c) = 3.0 (BROAD CREST)

PROGRAM SCHEDULE



```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  26 FEB 79
**********
    1          A1       ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
    2          A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF KEHLY RUN NO. 5
    3          A3       RATIOS OF PMF ROUTED THROUGH THE RESERVOIR  PA. 54-19
    4          B   288       0      15       0       0       0       0       0       0       0
    5          B1    5
    6          J     1       6       1
    7          J1  .1     .2      .3      .4      .5       1
    8          K     0       1                                       1
    9          K1       INFLOW TO RESERVOIR NO. 6
   10          M     1       1   0.29                                                        1
   11          P            22.3     117     127     136     143     145
   12          T                                                    1.0    0.05
   13          W  0.87    0.50
   14          X  -1.5     -.05     2.0
   15          K     1       2                                       1
   16          K        ROUTE THRU KEHLY NO. 6
   17          Y                                       1       1
   18          Y1    5                                                -1675      -1
   19          Y4 1675    1676    1677    1678  1678.5    1679    1680    1685    1690
   20          Y5    0     110     310     570     730     900    1260    3940    7830
   21          SA    0      21      46      92
   22          SE 1669    1675    1680    1700
   23          SS 1675
   24          SD1678.5     3.0     1.5    1200
   25          K     0       3                                       1
   26          K1       INFLOW TO RESERVOIR NO. 5
   27          M     1       1   0.11                                                        1
   28          P            22.3     117     127     136     143     145
   29          T                                                    1.0     .05
   30          W  0.87    0.50
   31          X  -1.5     -.05     2.0
   32          K     2       4                                       1
   33          K1       COMBINE
   34          K     1       5                                       1
   35          K1       ROUTE THRU RESERVOIR NO. 5
   36          Y                                       1       1
   37          Y1    1                                               -1660      -1
   38          Y4 1660  1660.5    1661  1661.5    1662  1662.5    1663    1664    1665    1670
   39          Y5    0      40     120     230     370     530     720    1140    1740    6240
   40          SA    0       8      23
   41          SE1639.7    1660    1680
   42          SS 1660
   43          SD1663.1     3.0     1.5    1150
   44          K    99
```

```
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79

RUN DATE= 80/01/15.
      TIME= 07.35.36.

                ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
                HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF KEHLY RUN NO. 6
                RATIOS OF PMF ROUTED THROUGH THE RESERVOIR  PA. 54-19

                                JOB SPECIFICATION
      NO      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
     288       0       15        0        0        0        0        0        0        0
                                JOPER      NWT    LROPT    TRACE
                                    5        0        0        0

                MULTI-PLAN ANALYSES TO BE PERFORMED
                NPLAN= 1 NRTIO= 6 LRTIO= 1
      RTIOS=    .10     .20     .30     .40     .50    1.00

                SUB-AREA RUNOFF COMPUTATION

      INFLOW TO RESERVOIR NO. 6

                ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                    1       0       0       0       0       0       1       0       0

                HYDROGRAPH DATA
      IHYDG    IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO  ISNOW  ISAME  LOCAL
          1       1     .29    0.00     .29    0.00   0.000      0      1      0

                PRECIP DATA
                SPFE     PMS      R6     R12     R24     R48     R72     R96
                0.00   22.30  117.00  127.00  136.00  143.00  145.00    0.00

TRSPC COMPUTED BY THE PROGRAM IS  .800

                LOSS DATA
      LROPT   STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
          0    0.00    0.00    1.00    0.00    0.00    1.00    1.00     .05    0.00    0.00

                UNIT HYDROGNAPH DATA
                TP=    .87    CP= .50    NTA= 0

                RECESSION DATA
                STRTQ= -1.50    QRCSN=  -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 3.67 AND R= 4.76 INTERVALS

      UNIT HYDROGRAPH 28 END-OF-PERIOD ORDINATES. LAG=    .87 HOURS. CP=  .50  VOL= 1.00
       14.     52.     91.    105.     93.     75.     61.     49.     40.     32.
```

HYDROGRAPH ROUTING

ROUTE THRU KEHLY NO. 6

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
4	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	1675.	1

STAGE	1675.00	1676.00	1677.00	1678.00	1678.50	1679.00	1680.00	1685.00	1690.00
FLOW	0.00	110.00	310.00	570.00	730.00	900.00	1280.00	3940.00	7830.00
SURFACE AREA=	0.	21.	46.	92.					
CAPACITY=	0.	42.	205.	1559.					
ELEVATION=	1669.	1675.	1680.	1700.					

CREL	SPWID	COOW	EXPW	ELEVL	COOL	CAREA	EXPL
1675.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1678.5	3.0	1.5	1200.

14 SUB-AREA RUNOFF COMPUTATION

INFLOW TO RESERVOIR NO. 5

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.11	0.00	.11	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	22.30	117.00	127.00	136.00	143.00	145.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= .87 CP= .50 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 3.67 AND R= 4.76 INTERVALS

UNIT HYDROGRAPH 28 END-OF-PERIOD ORDINATES, LAG= .87 HOURS, CP= .50 VOL= 1.00

5.	20.	34.	40.	35.	28.	23.	19.	15.	12.
10.	8.	6.	5.	4.	3.	3.	2.	2.	1.
1.	1.	1.	1.	1.	0.	0.	0.		

0 END-OF-PERIOD FLOW

HYDROGRAPH ROUTING

ROUTE THRU RESERVOIR NO. 5

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1660.	-1

STAGE	1660.00	1660.50	1661.00	1661.50	1662.00	1662.50	1663.00	1664.00	1665.00
1670.00									
FLOW	0.00	40.00	120.00	230.00	370.00	530.00	720.00	1180.00	1740.00
2240.00									
SURFACE AREA=	0.	8.	23.						
CAPACITY=	0.	56.	351.						
ELEVATION=	1660.	1660.	1680.						

CREL	SPWID	COGW	EXPW	FLEVL	COGL	CAREA	EXPL
1660.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COOD	EXPD	DAMWID
1665.1	3.0	1.5	1150.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6
				.10	.20	.30	.40	.50	1.00
HYDROGRAPH AT	1	.29	1	102.	204.	306.	408.	511.	1021.
		(.75)		(2.89)	(5.78)	(8.67)	(11.57)	(14.46)	(28.92)
ROUTED TO	3	.29	1	60.	123.	199.	270.	344.	717.
		(.75)		(1.71)	(3.48)	(5.64)	(7.66)	(9.75)	(20.29)
HYDROGRAPH AT	3	.11	1	39.	77.	116.	155.	196.	387.
		(.28)		(1.10)	(2.19)	(3.29)	(4.39)	(5.48)	(10.97)
2 COMBINED	4	.40	1	87.	174.	282.	384.	486.	1012.
		(1.04)		(2.47)	(4.91)	(7.99)	(10.88)	(13.75)	(28.64)
ROUTED TO	5	.40	1	84.	170.	276.	377.	478.	1012.
		(1.04)		(2.37)	(4.82)	(7.82)	(10.67)	(13.54)	(28.67)

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	1675.00	1675.00	1678.50
	STORAGE	42.	42.	143.
	OUTFLOW	0.	0.	730.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1675.55	0.00	54.	60.	0.00	42.25	0.00
.20	1676.06	0.00	67.	123.	0.00	42.25	0.00
.30	1676.45	0.00	77.	199.	0.00	42.00	0.00
.40	1676.80	0.00	87.	270.	0.00	41.75	0.00
.50	1677.13	0.00	97.	344.	0.00	41.75	0.00
1.00	1678.46	0.00	141.	717.	0.00	41.75	0.00

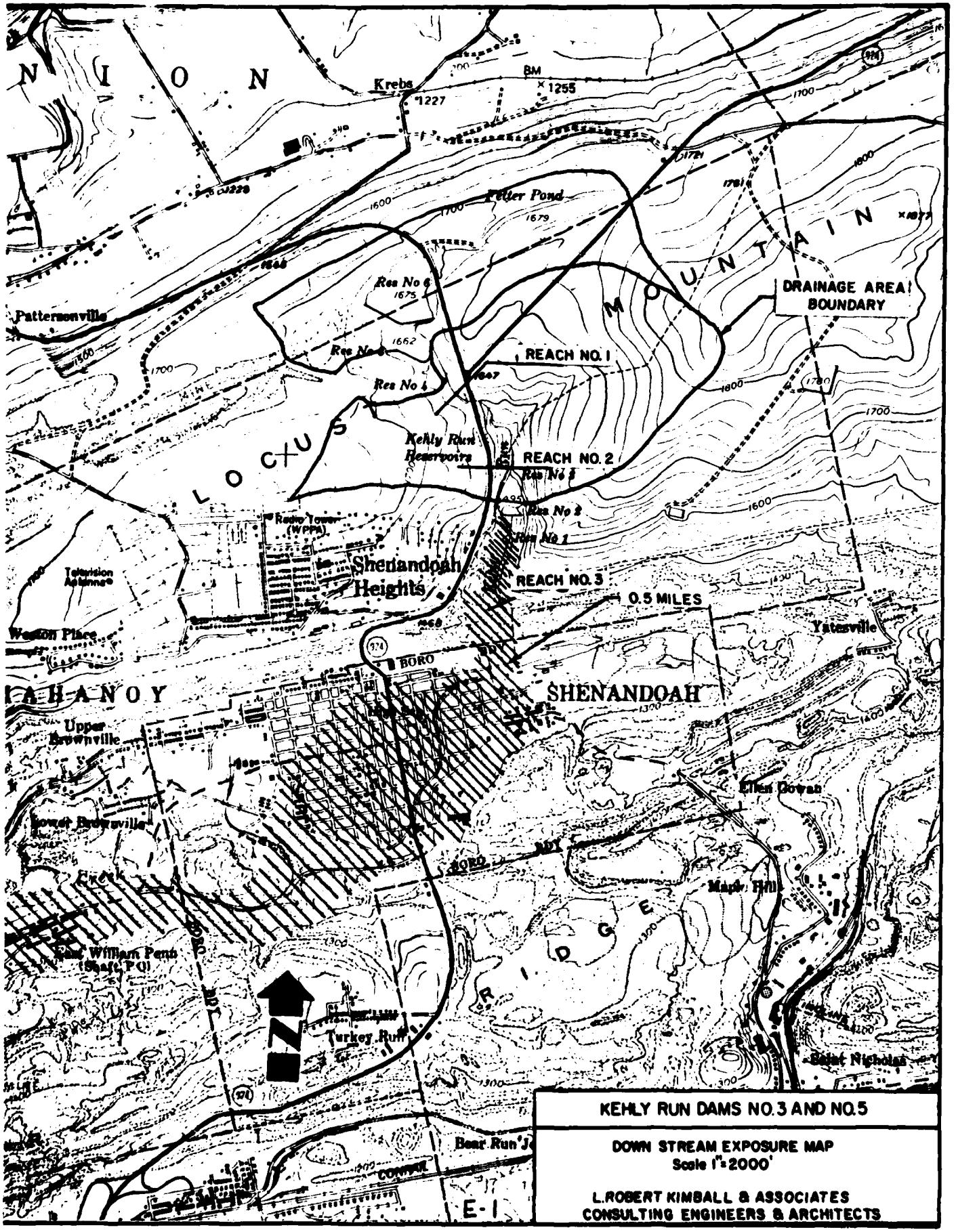
SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE SPILLWAY CREST TOP OF DAM

ELEVATION	1660.00	1660.00	1663.10
STORAGE	54.	54.	82.
OUTFLOW	0.	0.	766.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1660.77	0.00	60.	84.	0.00	42.25	0.00
.20	1661.23	0.00	64.	170.	0.00	42.00	0.00
.30	1661.66	0.00	68.	276.	0.00	41.75	0.00
.40	1662.02	0.00	71.	377.	0.00	41.75	0.00
.50	1662.34	0.00	74.	478.	0.00	41.75	0.00
1.00	1663.24	.14	83.	1012.	2.75	41.25	0.00

APPENDIX E
DRAWINGS

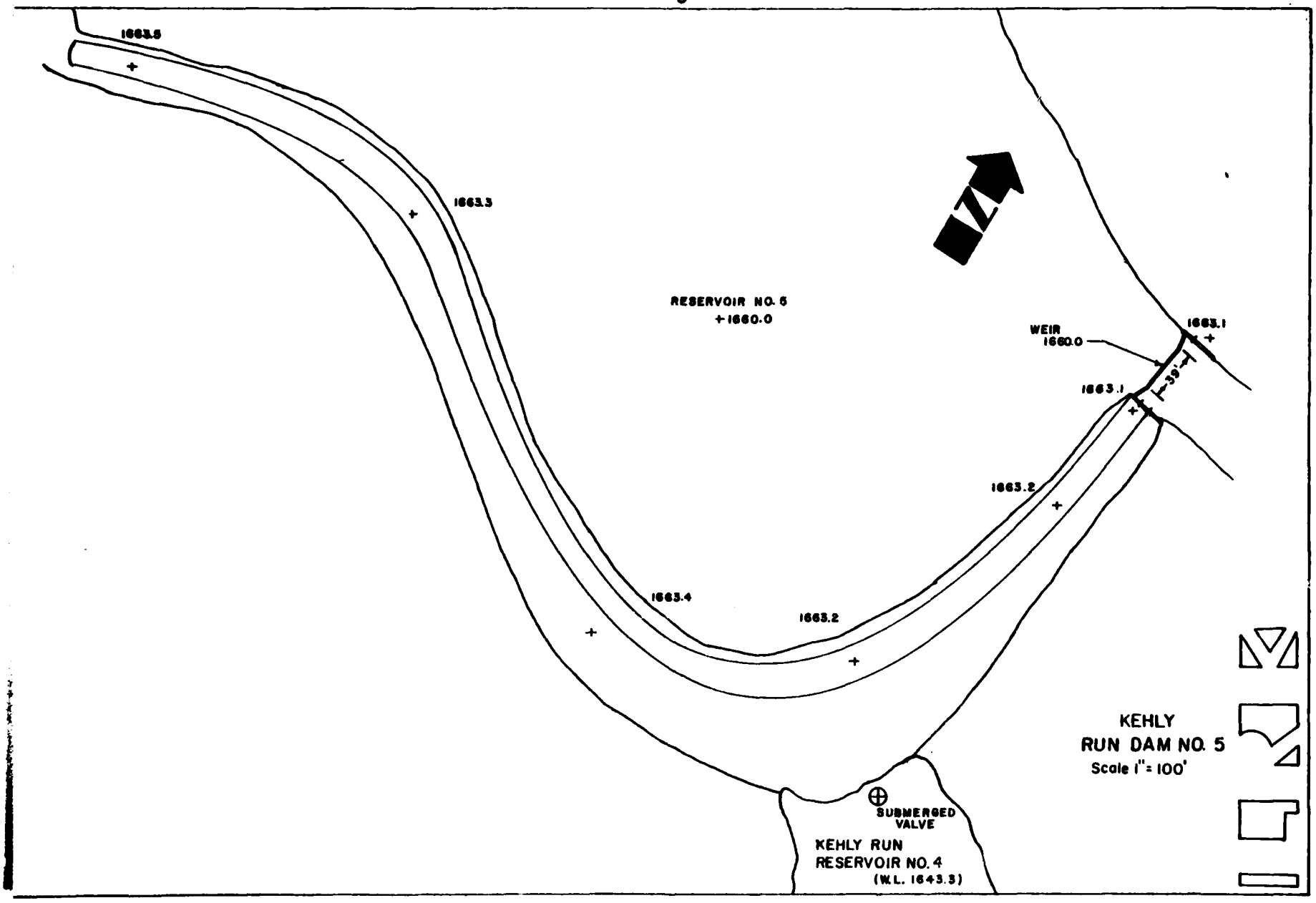

Krebs
BM
1255
1227
Keller Pond
1679
Res No 6
1675
Res No 5
1662
Res No 4
1667
Kehly Run Reservoirs
Res No 3
Res No 2
Res No 1
DRAINAGE AREA BOUNDARY
REACH NO. 1
REACH NO. 2
REACH NO. 3
0.5 MILES
Pattersonville
Locust
Mountain
Radio Tower (WPPA)
Shenandoah Heights
Television Antenna
Weston Place
BORO
SHENANDOAH
Yatesville
Upper Brownville
Lower Brownville
Creek
Ellen Bowan
Maple Hill
Saint William Penn (Shaft P O)
Turkey Run
Saint Nicholas
Bear Run
E-1
KEHLY RUN DAMS NO. 3 AND NO. 5
DOWN STREAM EXPOSURE MAP
Scale 1"=2000'
L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS

APPENDIX F
GEOLOGY

Kehly Run Dam No. 5 - General Geology

Kehly Run Dam No. 5 is located in the Appalachian Mountain Section of the Valley and Ridge Physiographic Province. This province is typified by numerous synclinal and anticlinal features. Some minor faulting is indicated to the south of the reservoir. The bedrock underlying the dam consists of the Pennsylvanian aged Pottsville Group. This unit consists of light to dark gray, fine grained to conglomeratic sandstone, with lesser amounts of shale, siltstone, limestone, coal and underclay. The bedding is generally well developed with the sandstones and siltstones often cross-bedded. Joints are usually regular and moderately well formed.

Both deep mining and surface mining of anthracite coal has taken place in the vicinity of this dam. The extent of any deep mining is unknown without extensive research.


1663.5
1663.3
RESERVOIR NO. 5
+1660.0
WEIR
1660.0
1663.1
39'-1
1663.1
1663.2
1663.4
1663.2
SUBMERGED
VALVE
KEHLY RUN
RESERVOIR NO. 4
(W.L. 1643.3)
KEHLY
RUN DAM NO. 5
Scale 1" = 100'

GEOLOGIC MAP OF THE AREA SURROUNDING RAVEN RUN DAMS NO. 2 AND 3, KEHLY RUN DAMS NO. 3 AND 5, BRANDONVILLE PUMPING STATION RESERVOIR

Pp — **Pottsville Group**

Predominantly sandstones and conglomerates with thin shales and coals, some [illegible] workable coals

ANTHRACITE REGION

Ppp — **Post-Pottsville Formations**

[illegible] sandstones and shales with some conglomerate and numerous workable coals

Pp — **Pottsville Group**

Light-gray to white [illegible] shales and conglomerates [illegible] Schuylkill and Lackawanna [illegible]

MISSISSIPPIAN

Mmc — **Mauch Chunk Formation**

[illegible]

F-2

SCALE 1:250,000